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PROCESSING TUNG OIL

Remarks of Dr. Henry G. Knight, Chief, Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, delivered at the annual meeting of the American Tung Oil Association, Tallahassee, Florida, April 3, 1940.

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It is a pleasure to join with you today in discussing one of the South's newest crops.

Tung oil, which is the product of this new crop, is just one of a number of vegetable oils produced in this country. Vegetable oils are not only valuable in the development of people but they are also important in the development of nations. The processing of these oils provides employment for thousands of people. The supply or lack of vegetable oils often plays an important part in war as well as in the economic life of civilized nations. The lack of agricultural fats and oils was one of the factors that led to the termination of the World War and these same products will undoubtedly play an important role in the present conflict.

This country's supply of agricultural fats and oils is derived largely from milk, livestock, cotton, corn, peanuts, soybeans, tung trees, and other farm and grove products. Tung oil is the newest member of this family. It's so new, in fact, that it might be classed as an infant among the other vegetable oils, but it has sufficient promise to make it exceedingly interesting at the present time.

While the production of tung oil in the United States is comparatively new, it is, nevertheless, fast becoming a product of considerable economic importance in the sections where the tung trees can be grown. But new as this enterprise is we have already advanced far enough to enable us to see that it is time to build the tung oil program on a solid foundation backed by scientific research. There is no place for purely promotional developments in an undertaking as promising as the tung oil enterprise appears to be. We need to look at this thing from the long-time point of view, and plan our program accordingly. We should look at the situation from the practical standpoint instead of the sensational side. We must face the facts, keep our feet on the ground, and build a constructive program that will enable us to advance in the proper way. And I want to take this occasion to commend the American Tung Oil Association for attempting to build its industry on a permanent instead of a spectacular foundation. That's just what the industry needs.

Tung oil is obtained by processing the nuts of the tung or China wood oil tree. The oil ranks second in importance in the drying oil industry and is used extensively in the manufacture of varnishes and enamels. The water-resisting properties tung oil imparts to the dried varnish and enamel films is attributed to the elaeostearic acid in it. And tung oil, by the way, is the only oil of commercial importance that contains this particular conjugated unsaturated fatty acid as its principal constituent.

The United States is dependent on China for its supply of tung oil. China has been the only source until we started production in this country a few years ago. In China the tung trees occur abundantly and grow luxuriantly between 26 and 34 degrees North Latitude and thrive in altitudes up to around 2500 feet above sea level. Importations of tung oil into this country have increased from around 75 million pounds in 1930 to more than 175 million pounds in 1937. The price rose from 7 cents a pound in 1930 to 15 cents in 1937 and 28 cents a pound in 1939. Imports have been falling off since 1937 due to war conditions in China. It is believed that final figures will show that imports in 1939 amounted to less than 80 million pounds. More than three-fourths of the tung oil used in this country goes into the manufacture of paint and varnish. And we should take steps to put our own tung oil industry on a sound footing in order to supply these and other industries with a safe source of domestically produced oil. With conditions as they are in the world today it isn't safe to depend on raw materials that have to come from warring nations. Where we can profitably do so it seems to me that it would be wise for us to begin to think about the production and processing of as many of the essential crops as possible in this country. Experience over the past 10 years shows that we can grow tung trees very well in certain sections of the United States, and we've done a good job thus far in the processing of the oil. The fact that you are gathered here today to talk over your problems indicates that you are planning to improve both the production and the processing of this increasingly important product. And that's fine.

Due to the fact that China has been producing tung oil for centuries, and that it is one of the country's major products, you might think that modern methods are used in the production and refining of this important oil. That, however, is not the case. Primitive methods are still employed in the production of tung oil in China. The oil as found in its natural state in the cells of the tung seeds is practically colorless and neutral in reaction, and when the oil is removed by the modern press process it should be light in color. And it is, when processed by modern American machines and methods. The oil produced in this country is very pale and practically neutral.

Tung oil is used for a great many things. The Chinese use it primarily as a waterproof covering for wood and other materials which they wish to protect from the weather. It is the principal paint oil of China, and is used as an ingredient in waterproofing masonry in that county. Chinese junks are oiled regularly with tung oil, and calked with a mixture of tung oil, lime and chopped hemp. Tung oil, after heat treatment, is added to native lacquer, changing the color from black to brown, and making the lacquer dry much faster. The oil is also used as an ingredient for dressing leather, and for varnishing furniture and floors. In the interior of China it is used to some extent as an illuminant, but the light given off is too smoky to be satisfactory. When burned to a soot, tung oil makes a finely divided carbon from which the Chinese make India ink. The soot formed when the pomace is burned is combined with the oil to make a paste for calking boats. Those are only a few of the many purposes for which tung oil is used in China. I've mentioned them to help you get a broader picture of the general use of this important product which has recently found its way into this country.

In the United States tung oil is used largely in the manufacture of paint and varnish. Its quick-drying and water-resisting qualities make it very valuable in the manufacture of these products. Tung oil represented about one-fifth of the leading oils used in the drying oil industry in 1939. The electrical industry reports tung oil as essential in the manufacture of certain insulating compounds used in dynamos, cables, and wire coatings. Tung oil is an important ingredient in some automobile brake linings. It has also been used in the gaskets on steam pipes, pumps, and engines. The undercoats of most automobile finishing jobs usually contain tung oil in some form. It is used in the production of linoleum, in oilcloth, and in waterproofing various types of fabrics, such as raincoats, balloon covers, and so on. It has also been used to some extent in the waterproofing of cartridge shells and for many other products requiring a waterproof coating. The money that goes out of this country for the purchase of tung oil amounts to more than 15 million dollars a year.

Since the foreign supply of tung oil is subject to sharp fluctuations in price and to uncertainty as to its availability, there is considerable interest in the development of a source of raw material in this country, and even in the development of other processed oils which could be used as a substitute for tung oil. As a result of these activities, and no doubt to the good work your association is doing, there is a growing interest in the production and processing of tung oil in the United States.

A few tung nuts found their way to this country around 1900. New interest was added in 1905 when a Plant Explorer of the Department of Agriculture, brought a small number of seeds into this country for experimental plantings. Commercial plantings began in 1923 and have increased until at the present time it is estimated that there are something like 175 thousand acres of tung trees in the United States. These plantings are confined largely to what we call the Gulf Coast Region. Roughly, this region includes a portion of about a half a dozen states--southern Georgia, northern Florida, and a strip of country about 100 miles wide extending back from the Gulf of Mexico in the States of Alabama, Mississippi, Louisiana, and a small portion of southeastern Texas.

The commercial processing and production of tung oil in the United States started in 1932 just 8 years ago when two tanks of tung oil containing more than 100 thousand pounds were shipped from Gainesville, Florida. In 1934, approximately 400 thousand pounds of tung oil were produced in Florida and Louisiana from tung nuts grown in the Gulf Coast Region. In 1936 the production had risen to 2 million pounds, and in 1938 to almost 3 million pounds. It's too early yet to say what the 1939 production will be because the processing is still under way in some sections.

The tung oil that is processed in this country is generally superior to that produced in China and has commanded a premium of from 2 to 4 cents a pound over the Chinese product. Its high specific gravity, high refractive index, low acidity, short time of polymerization with heat test, and excellent color are all noteworthy. Varnish manufacturers have reported, almost without exception, that they found the American oil superior to the imported oil for making varnish. They obtained a varnish which was paler and clearer, which dried quicker, and which gave a harder, tougher, more elastic, and more water-resistant film. This improved product is, in my opinion, largely the result of painstaking research for which America is noted. And, if the American tung oil industry will follow research as closely in the future as it has during the past few years and be guided by the results obtained, I believe that we will soon have a safe as well as a rapidly expanding tung oil industry in the United States. I might say in passing that it will take a great many tung trees to supply as much oil as we have been importing. It has been estimated that it would take around a million acres of tung trees to produce as much oil as we import each year. That, however, is a very general estimate, and the actual acreage might be larger or smaller depending on a great many factors some of which may have not even entered the picture at this time. I mention it merely to give you some idea of what may develop from the modest beginning that was made when a few tung nuts were planted in this country a comparatively short time ago.

There has been so much general interest in tung trees in the last few years that Congress appropriated money in 1938 to provide for scientific research in the growing and processing of this rapidly expanding Southern crop. This appropriation, as I pointed out at the annual meeting last year, is divided between the Bureau of Plant Industry and the Bureau of Agricultural Chemistry and Engineering. There are so many things that we need to know in connection with the production of tung oil in this country, and so little information available, that it was deemed advisable to use the scientists of two different Bureaus so as to attack the problem on as broad a scale as possible and as fast as possible.

There are two main divisions of this new Federal research program. One is what we call agronomic, that is, pertaining to the trees, and embracing such things as planting, varieties, cultivation, fertilizers, harvesting the nuts, breeding to develop more productive varieties, methods of propagation and so on. That part of the investigation, which, by the way, is the largest part of the research program, is being handled by scientists of the Bureau of Plant Industry.

The other part of the investigation pertains to the processing of the oil. It deals with the tung fruit and nuts after they have been harvested, and will study the content and characteristics of the oil produced under the various agronomic conditions as well as the utilization of tung oil and its byproducts. This part of the research, which is purely chemical and technological, is being carried out by scientists of the Bureau of Agricultural Chemistry and Engineering. I might add that these lines of research are being carried on in the closest possible cooperation, each supplementing the other.

The new Federal laboratories that have been set up to carry on this research are located at Gainesville, Florida, for the eastern part of the tung oil belt, and at Bogalusa, Louisiana, for the western section. There are now two chemists and a number of agronomists at Gainesville and a like number at Bogalusa. The Bogalusa laboratory is located on the second floor of the Post Office Building, and the Gainesville laboratory in the Woodbridge Building at 217 West Main South. I mention these locations so that those of you who desire to visit these laboratories may know where to go. And I'd like to say that visitors are welcome at all times. Just remember that the Government official hours are from 8 in the morning until 5 in the afternoon, and until 12 o'clock on Saturday, but the men usually work much later.

At Picayune, Mississippi, a pilot plant is being erected now to carry the research beyond the laboratory scale. The equipment for this plant is being furnished by L. O. Crosby & Sons, and it will be operated cooperatively by the Bogalusa laboratory and Mr. Crosby's company. Under the cooperative agreement the results of the research at this plant will be made available to the public. A pilot plant is, as most of you know, a semi-commercial plant or a commercial plant on a very small scale. It's the stepping stone between the test tube and the commercial plant, and a very important stepping stone at that, because test tube results don't always pan out successfully when tried out on a factory scale. The pilot plant bridges that gap. The pilot plant at Picayune will enable our scientists to make a semi or small commercial scale study of the solvent method of extracting the oil from the tung nut.

The method of extracting the oil in China and at present in this country is by squeezing it out in presses. This method leaves considerable oil in the cake, and we'd like to know whether we should continue to use presses or change to solvents. The tung kernel contains from 50 to 65 percent of oil and it is important that we know how much we are getting and how much is being left in the cake. The solvent method of extraction is being used with a great deal of success in the case of certain other seeds and nuts, and it may prove valuable in the case of tung oil. I might say that owing to the unique character of tung oil the usual solvent extraction methods are not applicable to the recovery of oil from the tung seeds. So we need to make further investigations in this field.

At the present time research is under way to try to determine how much oil can be recovered from the ordinary press cake that is produced today. The results of recent experiments, using a solvent and a small batch extractor with a capacity of only 30 pounds, showed that about 5 percent of oil could be recovered from ordinary fresh press cake. The oil that was extracted by this solvent method solidified on standing, but it didn't take the chemists long to solve that problem. They solved it by developing a heat treatment which renders the oil permanently liquid. But this, mind you, was in the laboratory and on a very small scale. The pilot plant that is now under construction will have a capacity of between 800 and a thousand pounds of press cake daily, and this will be sufficient to enable us to determine whether or not the solvent method of extracting oil from press cake will be profitable.

The pilot plant will enable us to do another thing. Some scientists believe that if we could find the proper solvent that the oil could be extracted without having to press the kernels. If this could be accomplished it might be a great help to the industry. It's worth investigating, and our scientists are going to try it out in the new pilot plant. They are already giving attention to the preparation of the kernels before the solvent is applied, as well as investigating the various grinding and flaking procedures best adapted to the solvent extraction method of obtaining the oil.

Another problem that our chemists are studying is the apparent loss of oil during mill operations. This apparent loss is based on the quantity of oil that is expressed from a known weight of kernels, and the amount left as indicated by an analysis of the press cake. This is an item of considerable importance, particularly in large operations since the data obtained at some mills indicate that oil losses in some instances amount to as much as 3 percent of the weight of the air-dried fruit. Some chemists believe this unaccounted for oil is left in the press cake and has undergone chemical changes so that it is not extracted by the solvent. Others believe that the loss is due to the fine particles of the kernels that are carried away by the blowers during the hulling operation. Nobody knows exactly just what causes this loss, but we are going to see if we can find out. This research will be carried on in cooperation with commercial mills, and remedies will be devised to recover all or as much as possible of this oil if we can find out the reason for its disappearance.

If, for example, our research shows that the oil is actually left in the press cake but has been chemically changed--polymerized is the technical term for this chemical change--by the heat of the expeller, then we can attack the problem from that angle. If our investigations show that some of the oil is being polymerized by the expeller, we'll probably try operating the expeller under milder conditions, and leave a little more oil in the cake and then see if we can obtain it by the use of a solvent. If we find that this loss of oil is due to the loss of kernels during the hulling operation, we'll attack the problem from that angle. In other words, we'll do everything we can to ferret out the reason for this apparent loss of oil, and then try if possible to devise means to recover it.

The age-old way of harvesting tung nuts is to let the fruits fall to the ground and then collect them after they have dried sufficiently to keep without heating and loss when stored. This results in the collection of large quantities of the hulls which surround the nuts. Are these fit for fertilizer? Can they be used in industry? Do they have possibilities as a source of tannic acid? Or how should they be disposed of to the best advantage? A profitable outlet for these hulls would help the entire industry. Our chemists will look into the possibilities in this field.

They also plan investigations to try to find out if the fruits should be allowed to remain on the ground after falling or if it would be more profitable to dry them in some sort of a mechanical dryer. We don't know the answer to this problem, but we do know that it is something that should be investigated. The proper solution to this problem might save considerable time now used in hauling the unnecessary hulls and it would undoubtedly help to reduce the losses caused by storing improperly dried kernels in the hulls.

Finally, there is the problem of what to do with the cake after the oil has been extracted from it. Due to the strong purgative properties of the tung meal or cake it is not suitable for feeding stock in its natural form. It undoubtedly has some value as a fertilizer, but just how much we don't know. It appears also to have possibilities for making lamp black and other things, but it will require research to determine how it can be used to the best advantage. A profitable outlet for this byproduct would help the tung oil industry just as the outlet for cottonseed meal has helped the cottonseed oil industry.

I could say a great deal more about the tung oil development in this country. But I have talked long enough. We are all intensely interested in this new and rapidly expanding Southern enterprise, and expect to do all we can to help make it succeed. The 3 million pounds of tung oil produced in this country in 1938 was a good showing for the short time we have been engaged in this new undertaking, but 3 million pounds is not a drop in the bucket compared to the more than 100 million pounds we import each year. So there is nothing to fear from the standpoint of overproduction, certainly not in the very near future.

It's hardly necessary for me to say to an audience like this that I believe in the development of a program that will increase and improve the production of tung oil in the United States. But there is one warning that I always try to sound in connection with this program. It is this. With the exception of the splendid work that has been done at a few Southern agricultural experiment stations, very little fundamental research has been done in this or any other country on the production and processing of tung oil. Generally speaking, we know very little about the chemical, technological, and agronomic angles involved in the production of tung oil. We are working largely in the dark because we have little to guide us. But we are working, and the research already under way, or to be started with the appropriation made by Congress, coupled with the investigations under way at the State experiment stations will, we hope, clear up some of the puzzling problems now confronting this new enterprise.

But don't expect research to solve all the tung oil problems in one day, or one year. The scientists who work in these laboratories are not magicians, and can't accomplish the impossible. They'll need **your** help and cooperation if they are to produce the most valuable results.

It is our plan to push this new research on tung oil as fast as possible. With your cooperation we hope to avoid costly mistakes, and thereby speed the development of a tung oil program that will be safe, sound, and profitable to all concerned as well as providing us with an ample supply of domestically produced oil.

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